

## TRIBUTARIES TO PEND OREILLE RIVER

### S. COCOLALLA LAKE

Waterbody Type: Lake  
Ecoregion: Northern Rockies  
Designated Uses: agricultural and domestic water supply, cold water biota, primary and secondary contact recreation, and Special Resource Water.  
Size of Waterbody: 805 acres (3.3 km<sup>2</sup>)  
Size of Watershed: 64.5 square miles (41,298 acres)  
TMDL Indicators: 8 ug/l total phosphorus  
Model Analysis: load-response relationship

#### *Summary*

Cocolalla Lake is impaired due to low dissolved oxygen and nutrient pollution. A target of 8µg/l total phosphorus was developed which, if achieved, should reduce the trophic level of the lake to a point where theoretically, internal nutrient cycling will not occur. If the internal nutrient cycling does not occur, the lake will meet the dissolved oxygen standard. The phosphorus load reduction of 2,693 kg/yr is 89% lower than existing conditions. The nutrient narrative standard will be met before the oxygen standard, as phosphorus reductions will reduce the occurrence of nuisance algal blooms.

#### **1. Physical and Biological Characteristics**

The Cocolalla Lake sub-watershed occupies a major portion of the land mass between the southern arm of Pend Oreille Lake and the Pend Oreille River. The sub-watershed area is approximately 60 square miles (155 km<sup>2</sup>) (Rothrock, 1995). The sub-watershed is heavily forested with foothill to mountainous terrain up to 4,500 feet (1,372 m) in elevation with slopes ranging from 15-50%. Cocolalla Lake is in the middle of the sub-watershed at about 2,200 feet (676 m) elevation. Average annual rainfall is about 37 to 40 inches (94 -102 cm), average maximum temperature during July and August is 80°F (26.7°C), and there can be many days above 90°F (32.2°C). The winters are cold and the lake usually freezes over by December.

There are five tributaries to Cocolalla Lake: Cocolalla Creek, Fish Creek, Butler Creek, Westmond Creek, and Johnson Creek. Cocolalla Creek is the only outflow from the lake, which flows into Round Lake and eventually into the Pend Oreille River. The last two miles of Cocolalla Creek comprises a large slough, whose water level is affected by the rise and fall of the Pend Oreille River level.

Cocolalla Lake has a surface area of 805 acres (3.3 km<sup>2</sup>) and a mean depth of 27.7 feet (8.4m). All but the east shoreline is developed with primarily seasonal homes. The lake receives heavy recreational use during all seasons, but especially during the summer months.

Dense conifer forest comprises 63% of the watershed, 20% is open conifer forest, 10% in cropland and grazing, with the remainder as clearcuts, home sites, and roads. Fifty percent of the watershed is privately owned.

Cocolalla Lake is bordered by batholith granites near Black Pine Mountain (Rothrock, 1995). The bedrock consists of the Selkirk Crest quartz monzonite (Tertiary) and metamorphic rocks (Precambrian). The valleys are filled with sediments from: erosion of the mountains, lake deposits, glacial till, and glacial outwash. There are three general soil map units common in the watershed, each with one or more detailed map units. In the foothills and mountains the general soil unit is the Pend Oreille-Rock outcrop-Treble on 5-65% slope. These soils are considered poorly suited to roads, dwellings, and recreational development due to slope, a hazard of erosion, and the areas of Rock outcrop. The second soil unit is the Bonner gravelly silt loam. Runoff from this soil is slow and the hazard of water erosion is slight. It is found along Cocolalla Lake shoreline and is poorly suited for septic systems. It is well suited for hay, pasture and livestock grazing. The third soil unit is the Hoodoo-Pywell-Wrencoe, which is a very deep poorly drained soil and subject to long periods of standing water.

## **2. Pollutant Source Inventory**

### Point Source Discharges

Previous to 1999, there were periodic unauthorized discharges to Johnson Creek and Cocolalla Lake of untreated sewage from the Sandy Beach Resort sewage lagoon. The lagoon has been in use since the early 1970's. In May of 1999, the lagoon was drained and the new community drainfield was fully operational.

### Nonpoint Source Discharges

Historically, there have been numerous severe land disturbing activities which contributed large amounts of sediment and associated nutrients, as well as direct nutrient inputs, to the lake. These human caused sources of pollution included dairies located along tributaries, heavy logging activity, failed sewage systems, urban development, heavy grazing and feedlots in bottom lands, and creek channelization.

Currently, nutrient transport to the lake has been reduced by better land use practices and infrastructure improvements. There are now two systems used for sewage disposal, individual septic systems and two community drainfields. The community drainfields have replaced some of the failed septic systems found along the lake. Grazing pressure has been reduced in some areas, and dairies and feedlots are no longer present. Nutrient contributions to the lake from livestock are now primarily from bank destabilization along tributaries. Forest harvesting practices have improved, however, harvesting pressure remains high. Urban growth is a new and increasingly significant factor in nutrient contribution to the lake. Relatively unregulated development and lack of enforcement for the existing county stormwater ordinance results in stream and lake sedimentation. An extensive network of poorly constructed roads also contribute to this sediment loading.

In the Phase I Diagnostic Study, Rothrock concluded that 23% of the phosphorus loading was internally generated from anoxic and aerobic sediments, and macrophyte decay. Reduction of internal phosphorus loads would greatly reduce the growth of algae which would in-turn, reduce or eliminate the formation of anoxic conditions. To break this nutrient recycling, would likely involve an in-lake chemical treatment, combined with a concentrated effort to reduce external nutrient sources to provide a lasting benefit.

## **2.a. Summary of Past and Present Pollution Control Efforts**

In the 1950s the lake was managed as a cutthroat fishery. In 1957 the Cocolalla drainage system received a rotenone treatment to eliminate spiny ray and trash fish, and then was planted with cutthroat. Since then however, competition from warm water fish, decreasing water quality, and degradation of stream segments causing low salmonid spawning success has made the lake marginal for natural trout production. Current management by the Idaho Fish and Game includes maintaining the trout fishery by stocking catchable rainbow trout or fingerlings, and stocking channel catfish. Warm water fish spawn successfully in the lake.

In the falls of 1978 and 1983 the development of a dense blue-green algae blooms led to a heightened awareness of the public concerning the water quality of Cocolalla Lake. In 1983 a public notice was issued advising against using the lake for drinking water or primary contact recreation due to potential blue-green algae toxins. As a result the Cocolalla Lake Association was formed in 1985, with the goal of reversing the lake eutrophication process and preserving its beneficial uses. With over 100 members this group became very strong advocates of pollution reduction and prevention, and successful in their efforts to educate the public.

In 1990, the lake and Cocolalla Creek were designated as Stream Segments of Concern under Idaho's Antidegradation Program. A committee made up of local groups and resource agencies, identified issues significant to water quality degradation in the watershed. Three site specific best management practices for timber harvesting were recommended by the committee and implemented by Idaho Department of Lands.

In 1994 the Bonner Soil Conservation District was awarded a State Agricultural Water Quality Program (SAWQP) grant to pursue measures to reverse the accelerated eutrophication of Cocolalla Lake and its tributaries. Tasks accomplished were:

1. Publish and distribute four newsletters.
2. Distribute information packets at public events.
3. Conduct four educational workshops that address watershed pollution issues.
4. Provide a water awareness educational program for school children.
5. Purchase a sign which identifies the SAWQP project area.
6. Purchase an environmental educational program for use by students and adults.
7. Construct fire pits and signs.
8. Provided fish passage on Fish Creek through the culvert to Cocolalla Lake.

A feasibility study examining alternatives for controlling nutrient loading into Cocolalla Lake was developed by Montgomery Engineers (JMM, 1993). From this list, the Cocolalla Lake Watershed Management Plan was developed by the Bonner Soil Conservation District in 1996. Goals of this plan were:

1. Reduce phosphorus loading from existing septic systems.
2. Restrict increased phosphorus loading from future development
3. Minimize nonpoint source pollution associated with urban and residential land use

- runoff entering the tributaries and lake.
4. Minimize nonpoint source pollution associated with pasture and hayland uses.
  5. Minimize nonpoint source pollution associated with forest land uses.

Restoration projects completed in 1996-'97 by the Cocolalla Lake Association were:

1. Road improvements on Cocolalla Loop Road at Fish Creek, implementation of Bonner County's Stormwater Ordinance, and the development of a stormwater and erosion control plan for Fish Creek Road and Cocolalla Loop Road.
2. Fence construction and repair along the Idaho Fish and Game property.
3. Training of a Streamwalk Team and their annual public education efforts.

### **3. Water Quality Concerns and Status**

Nutrient pollution in Cocolalla Lake causes periodic blooms of blue-green algae. These blooms curtail recreational use in the late summer and cause the dissolved oxygen levels to fall below minimum standards set by Idaho.

#### **3.a. Applicable Water Quality Standards**

Cocolalla Lake was listed as impaired due to unspecified "pollutants", nutrients and dissolved oxygen in the 1996 303(d) list. It has designated beneficial uses of agricultural and domestic water supply, cold water biota, primary and secondary contact recreation, and is designated as a Special Resource Water.

Idaho's water quality standard for excess nutrients is as follows, "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."

Idaho's water quality standard for dissolved oxygen is that the concentration must exceed 5mg/L at all times. This standard does not apply to (1) the bottom 20% of water depth, where depths are 115 feet (35 meters) or less, or (2) waters of the hypolimnion (deepest water) in stratified lakes.

#### **3.b. Summary and Analysis of Existing Water Quality Data**

Cocolalla Lake has had several water quality studies conducted over the last twenty years. In the mid-1970s IDEQ (Johann 1974 and Trial 1976) assessed the lake's trophic status. The conclusion was that the lake was either meso-eutrophic or eutrophic, with secchi disk transparency measurements around 5 feet (1.5 m) and hypolimnion oxygen depletion. Nutrient input was identified to be from heavy grazing and haying along tributaries, and septic tank leaching from lakeshore homes.

In 1986 a one year lake study (Falter and Good 1987) determined that the lake was phosphorus limited and meso-eutrophic. Falter also provided a table of phosphorus export coefficients selected for the characteristics of the Cocolalla watershed.

Cocolalla Creek and Cocolalla Lake were also designated as Stream Segments of Concern under

Idaho's Antidegradation Program in 1989. The resulting report established site specific best management practices for Cocolalla Creek. These included pre-operational inspections for Class I stream crossings and for those operations that will involve road construction or major reconstruction.

From 1990 to 1992 IDEQ conducted a diagnostic monitoring program of the Cocolalla Lake watershed. Rothrock found that the lake trophic status was between meso-eutrophic and eutrophic, similar to the mid-1970s finding (Rothrock 1995). Low dissolved oxygen (<1.0 mg/l) began at 23 feet (7 meters) which comprises 24% of the total lake volume. The anoxic layer did not develop in the winter months. From approximately 31 feet (9.5 m) to maximum lake depth, low oxygen levels allowed phosphate to be released from bottom sediments. This high layer of phosphate comprised 7% of the total lake volume. This internal nutrient cycling accounted for 23% of the estimated annual phosphorus load in the lake from October 1990 through September 1991. Even though in theory, if phosphorus is reduced over a period of years internal nutrient cycling will eventually disappear, modeling shows that this might not be achievable for Cocolalla Lake. Therefore, a treatment, such as alum, may be necessary to stop the internal nutrient cycling, and the phosphorus inputs to the lake reduced to maintain the benefits of the alum treatment.

Rothrock found that the five lake tributaries contributed 63% of the estimated total annual phosphorus loading to the lake, which is high compared to other north Idaho lakes. Cocolalla Creek (inlet) accounted for 40% of the tributary loading. Two main factors that contribute to this condition are grazing animals and septic tank leachate from homes along the stream.

A 1995 survey of streams in the Cocolalla watershed showed only minor problems related to phosphorus contributions from agricultural activities (Blew 1995). This information is contrary to data collected by Rothrock in 1990-91 which indicated that 15% of the phosphorus load is in the form of orthophosphate. This indicates that at least 15% of the load is animal in origin. Blew also reported that stream channelization increased bank erosion but most of these areas have healed and no longer represent significant erosion problems. Some localized streambank damage due to grazing was found. Blew described these as small and localized and not considered a significant problem to water quality.

Results of shoreline lake water sampling did not indicate bacterial contamination problems. However, the northern public swimming area may be threatened due to high summer bacterial counts entering from Westmond Creek (Rothrock 1995). Rooted aquatic plants do not appear to interfere with recreational use. Less than 4% of the lake is covered by macrophytes, primarily in the southern bay.

### **3.c. Data Gaps for Determination of Support Status**

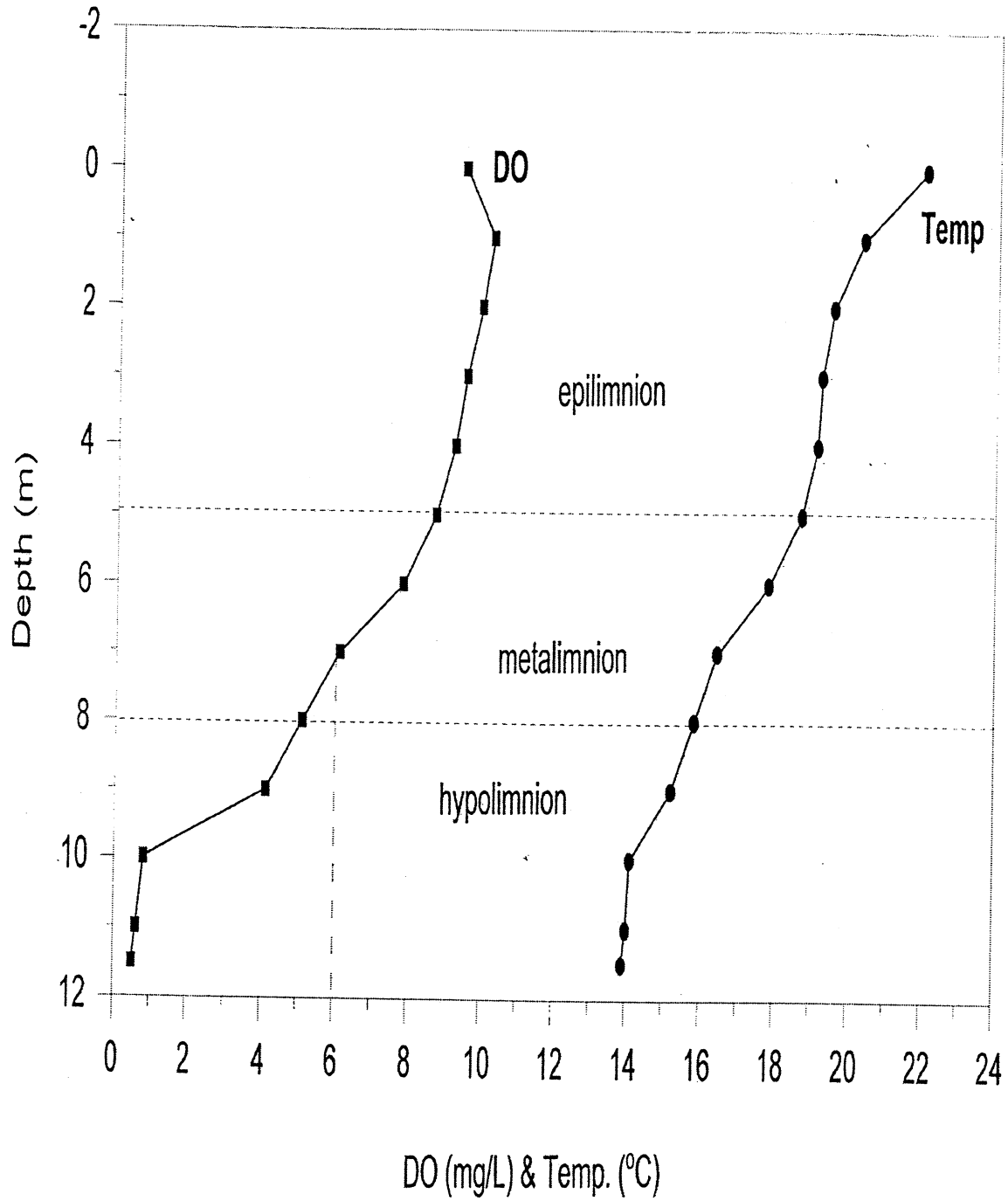
DEQ's new Large Waterbody Assessment Guidance was not available for use in this TMDL. Data for this beneficial use support status work was collected in 1998.

## **4. Conclusion of Problem Assessment**

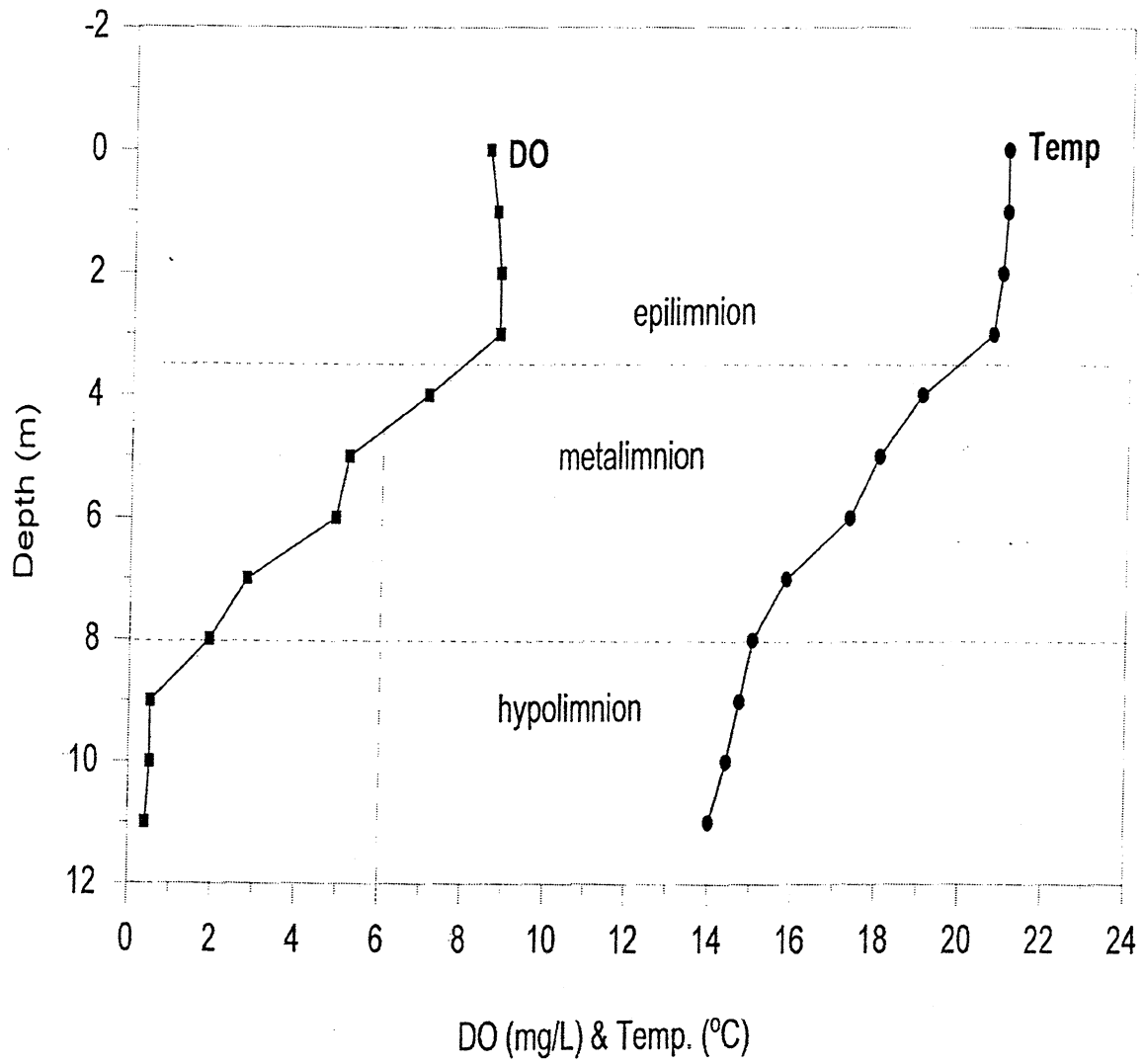
### Dissolved Oxygen

# Cocolalla Lake Profile

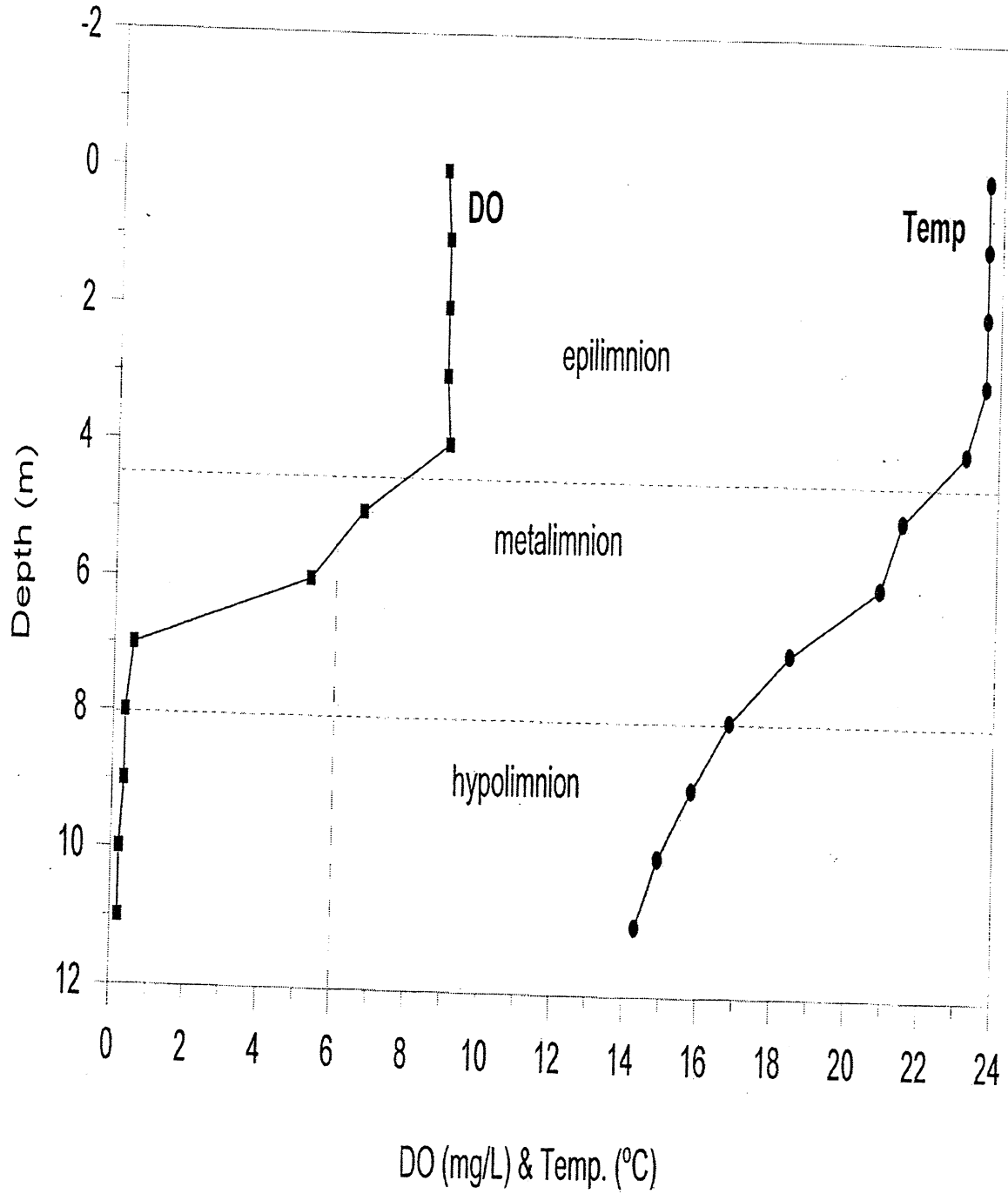
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Cocolalla Lake Profile  
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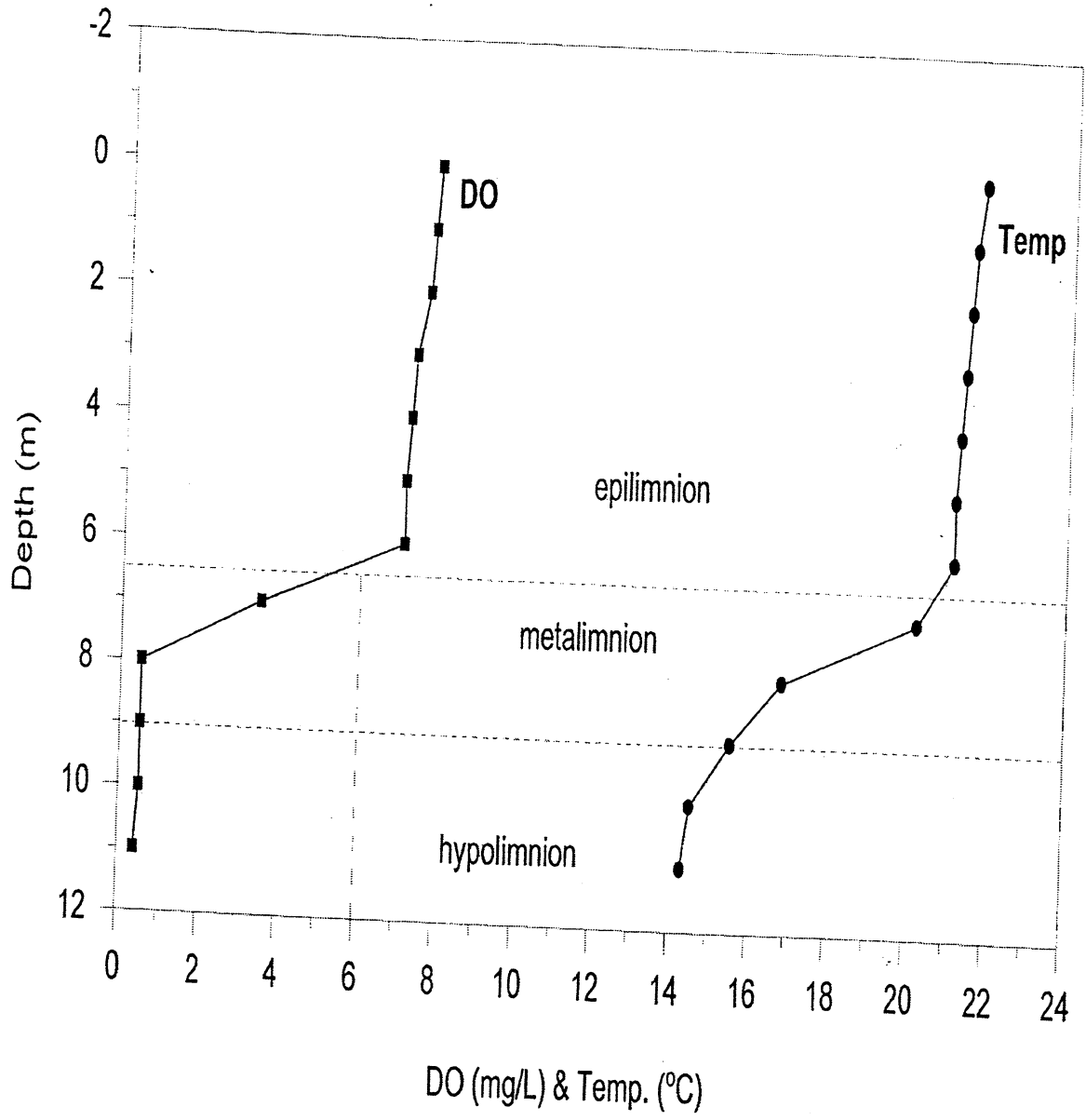


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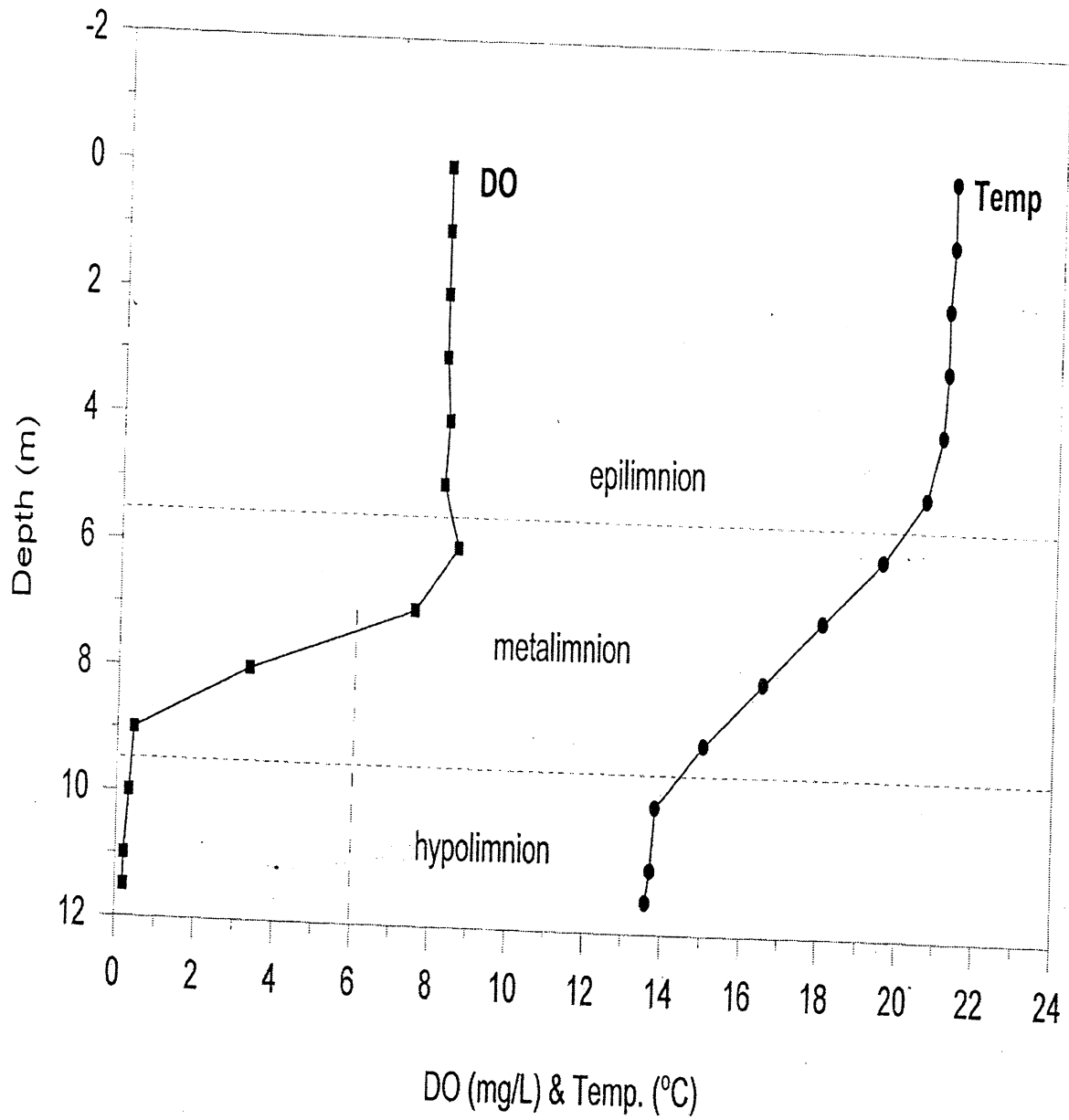


# Cocolalla Lake Profile

08/26/91

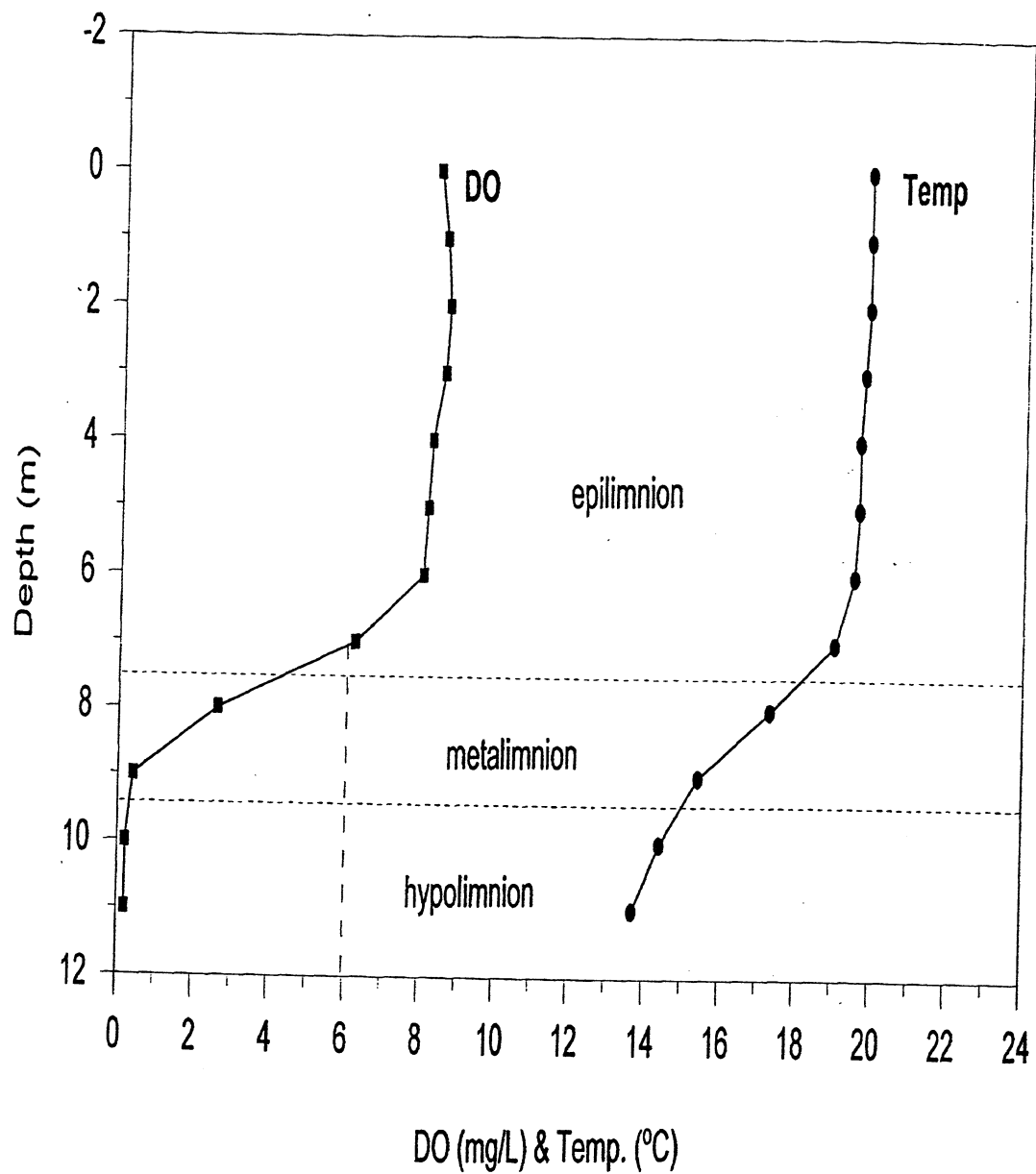


Cocolalla Lake Profile  
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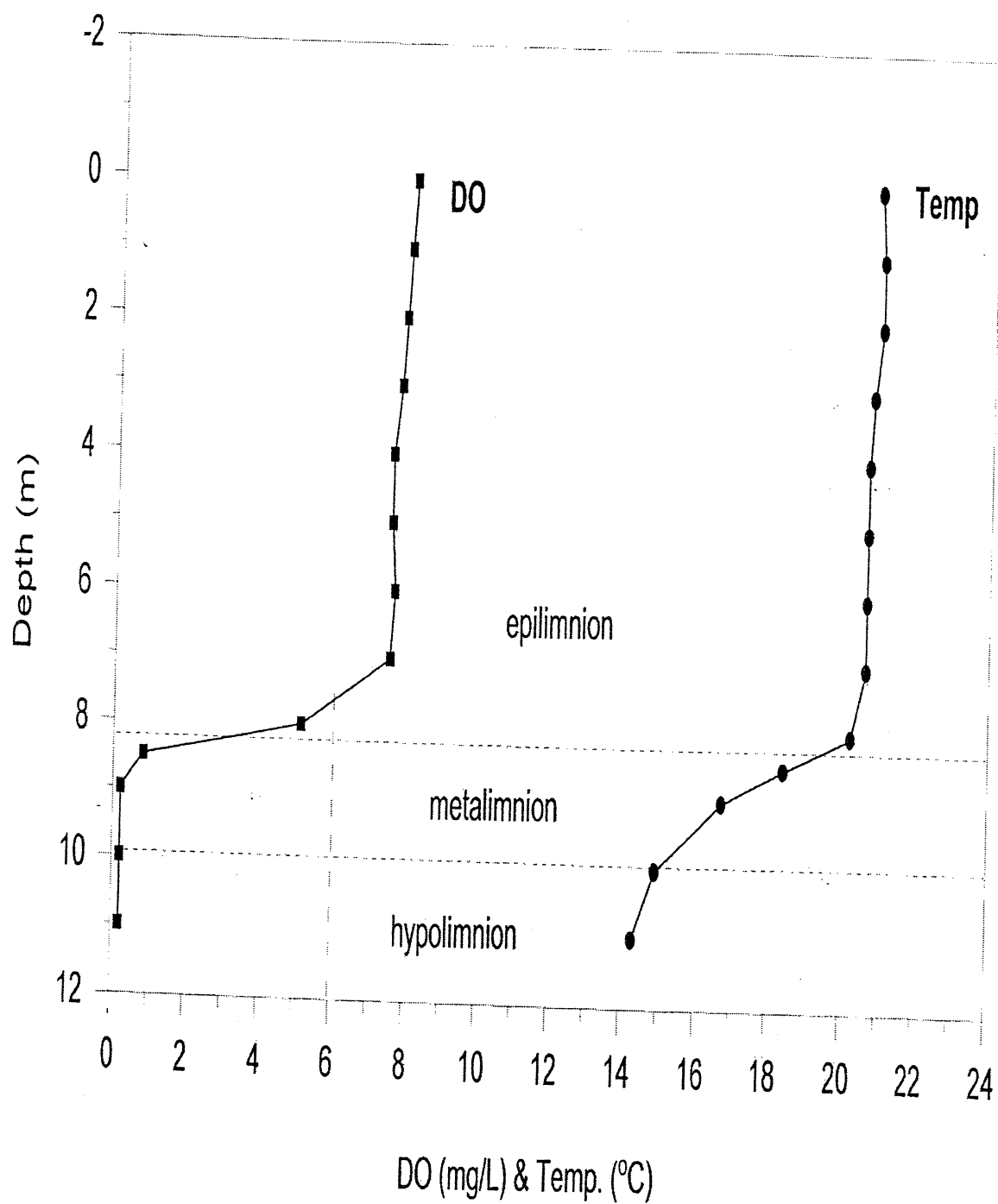
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07/10/92



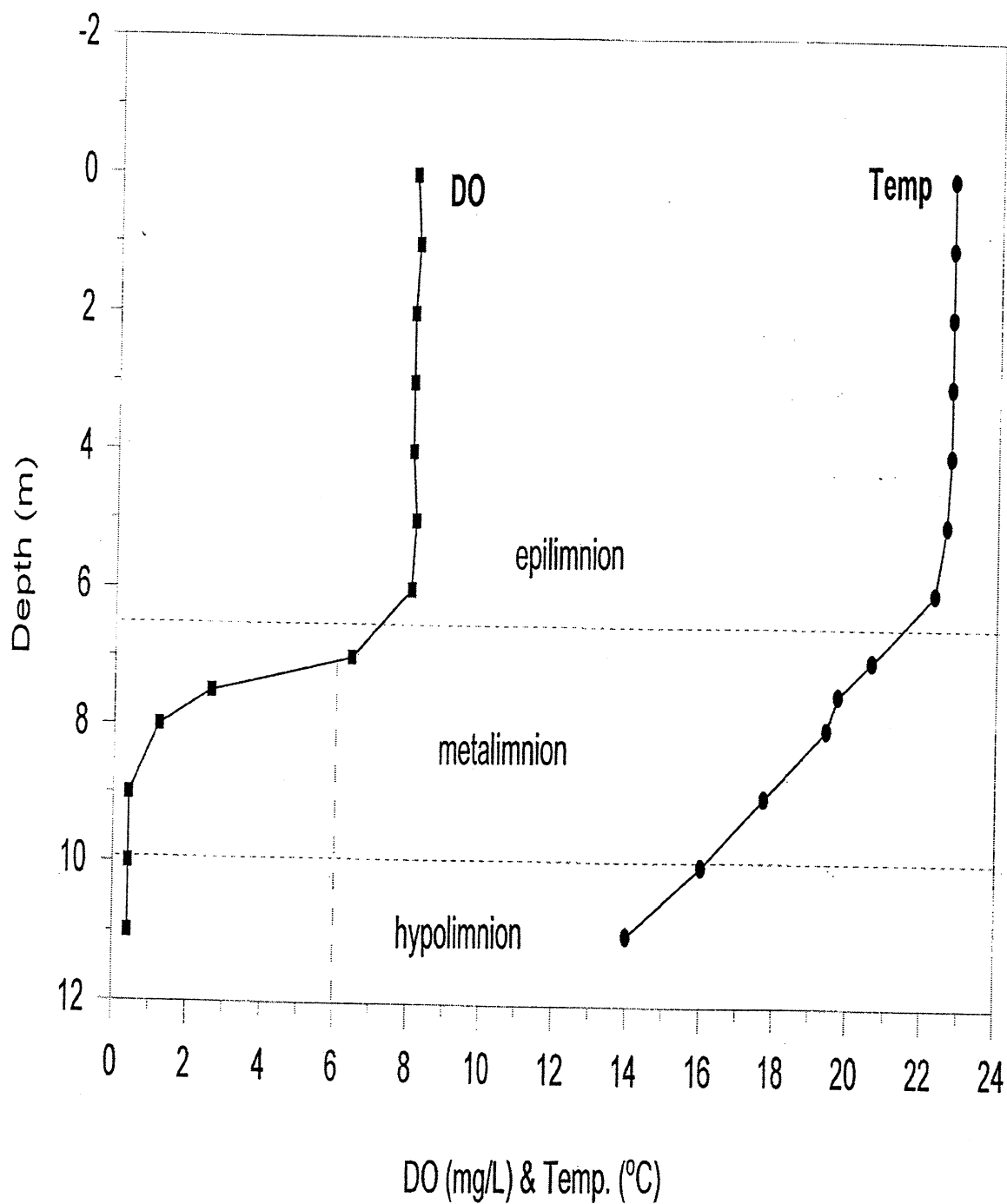
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07/24/92

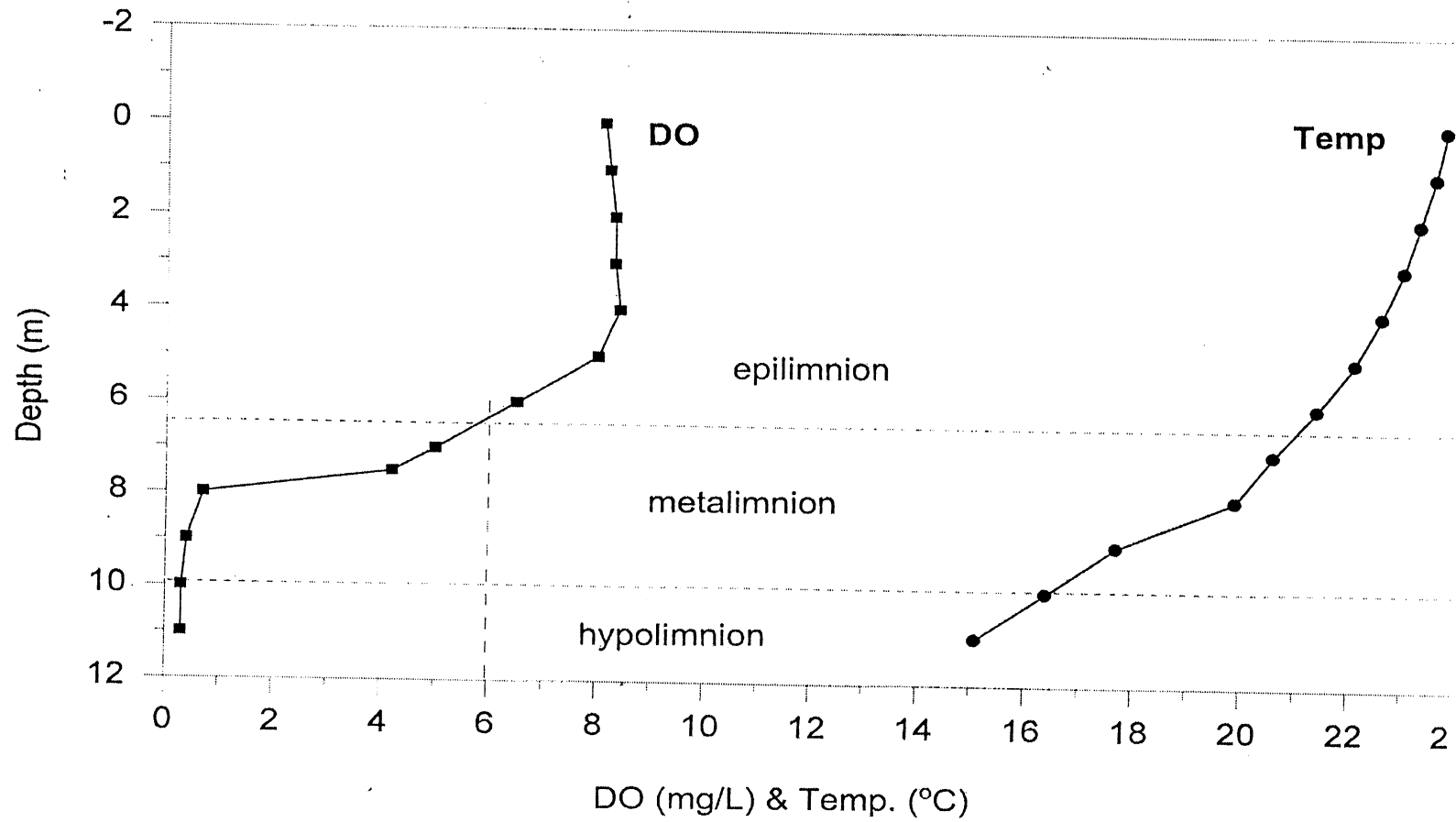


# Cocolalla Lake Profile

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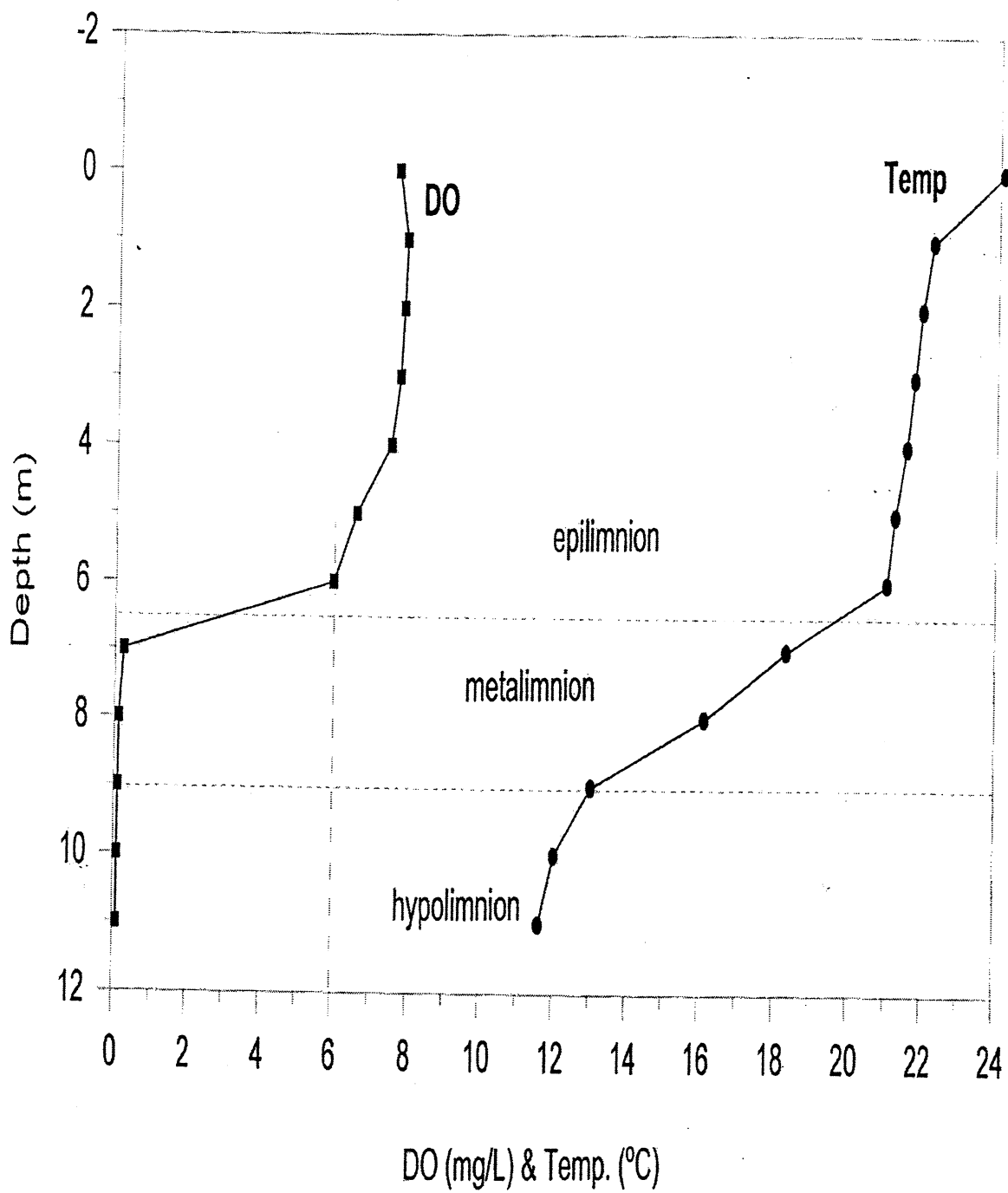


Cocolalla Lake Profile  
08/18/92



# Cocolalla Lake Profile

BURP - 08/18/97



Data shows that Cocolalla Lake does not meet Idaho's dissolved oxygen standard for cold water biota, a designated use. In 1992, waters 23 feet (7 m) and deeper fell below the 5 mg/l standard and comprised greater than the bottom 20% of water depth in the lake (24% < 1.0mg/l). The area of low dissolved oxygen was above the hypolimnion in all samples for both years of the study, 1991 and 1992. In conclusion, Cocolalla Lake will require a TMDL that achieves compliance with Idaho's dissolved oxygen standard.

#### Nutrients

Newspaper articles from the early 1980s describe recreational use impairment due to excess nutrients in Cocolalla Lake. In 1991 a blue-green algae bloom was noted by Rothrock, however, it was not as severe as those seen in years 1986, 1988, 1989 and 1993. Based upon this evidence, the lake appears to substantially and chronically violate Idaho's narrative nutrient standard. Achieving compliance with the dissolved oxygen standard should also remove the impairment due to excess nutrients.

### **5. TMDL- Loading Analysis and Allocation**

**Problem Statement:** Cocolalla Lake does not meet the water quality standards for dissolved oxygen and nutrients.

#### **5.a. Numeric Targets**

Dissolved oxygen must reach or exceed 5 mg/l in the upper 80% of the lake water depth and above the hypolimnion and excess nutrients cannot impair beneficial uses.

#### Nutrients

The WERM modeling (JMM 1993) demonstrated that a phosphorus reduction of 39% resulted in an epilimnetic phosphorus concentration of 16  $\mu\text{g/l}$ , a chlorophyll *a* value around 8.5  $\mu\text{g/l}$  and a secchi depth of 10 feet (3.1 m). These conditions roughly equate to conditions present in the lake in 1992. Based upon the opinion of the Cocolalla Lake Steering Committee this level of water quality achieves full support of recreational uses, thus, in compliance with Idaho's nutrient standard. The year 1992 was marked by low spring flow conditions and low nutrient loading from tributaries. The 39% reduction in total phosphorus equates to a load reduction of 1,265 kg/yr, based upon the model's estimated load of 3,244 kg/yr. The margin of error for this model is unknown. Allowing for an approximated 20% error, the target reduction to achieve full support of recreational uses is 1,518 kg/yr (1,265 X 20%).

#### Dissolved Oxygen

Studies done in the Cocolalla Lake watershed focused on meeting the nutrient standard, not the dissolved oxygen standard. Consequently there was no link between nutrient reduction and dissolved oxygen levels. Data shows that meeting the nutrient target reduction of total phosphorus (1,518 kg/yr) will not achieve the desired oxygen levels in the lake.

Using the JMM model, a reduction of in-lake total phosphorus from 22 to 16  $\mu\text{g/l}$  moves the lake trophic level to a borderline mesotrophic-eutrophic lake (JMM 1993). An additional reduction to 10  $\mu\text{g/l}$  may, in theory, move the trophic level of the lake to a state where there is no internal nutrient cycling (mesotrophic). A target of 10  $\mu\text{g/l}$  total phosphorus requires a load reduction of 2,244 kg/yr, a 69% load reduction from existing conditions. This target is the low end of the recommended range of phosphorus concentrations (10-30  $\mu\text{g/l}$ ) that the U.S. EPA *Water Quality*

*Criteria 1972* (blue book) provides for lakes which are found to be relatively uncontaminated. This nutrient target should be sufficiently conservative to insure compliance with the dissolved oxygen standard. Including a 20% margin of safety makes the final target **8µg/l** total phosphorus with a reduction of **2,693 kg/yr**, an 89% load reduction from existing conditions.

## 5.b. Source Analysis

Based upon Rothrock's investigation, total phosphorus load to the lake from October 1990 thru September 1991 was 2,209 kg. Tributaries contributed 63% of the total phosphorus load and internal nutrient cycling accounted for 23%. These estimated values are compared to the Watershed Eutrophication Reduction Management modeled values of phosphorus loading to Cocolalla Lake in Table 1.

Table 1. WERRM Phosphorus Load Modeling Compared to IDEQ Estimates, 1991 (Rothrock 1995).

Source	*IDEQ (kg/yr)	WERM (kg/yr)
<hr/>		
Tributaries		
Cocolalla Creek	552	883
Fish Creek	283	334
Westmond Creek	273	353
Butler Creek	155	114
Johnson Creek	124	100
	-----	-----
Subtotal	1,387	1,784
Septic Systems	54	118
Atmosphere (dryfall and precipitation)	111	242
Internal Loading	500	1,100
	-----	-----
Total	2,052	3,244

\*The IDEQ estimates for phosphorus loading do not include loads for groundwater of 50 kg/yr and surface overflow into the lake of 107 kg/yr. There were no estimates for these parameters in the WERM model.

IDEQ loading estimates correspond to the measured seasonal average concentrations of the following parameters: euphotic zone total phosphorus of 20 µg/l; secchi disk reading of 2.1 meters; a concentration of chlorophyll *a* of 12.9 µg/l, and observed persistent blooms of blue-green algae.

The WERRM model loading estimates correspond to an in-lake total phosphorus concentration

of 22 µg/l and a chlorophyll a of 12 µg/l. At this phosphorus level the lake was classified as eutrophic. By reducing the epilimnetic phosphorus concentration to 16 µg/l, the predictive chlorophyll *a* value was around 8.5 µg/l and an associated secchi depth of 3.1 meter. This equated to a 39% reduction of annual phosphorus loading. Again, this model did not examine conditions which would meet the dissolved oxygen standard.

### 5.c. Linkage Analysis

Monitoring will be of dissolved oxygen, the parameter that is directly impaired.

### 5.d. Allocations

Tributary phosphorus loading accounted for 55% of the total load to the lake. Septic systems contributed 3.6% of the load, atmospheric load was 7.5% and internal loading accounted for 34% of the total load (Table 2.). Allocations for each of these sources is found in Table 3.

**Table 2.** Tributary Phosphorus Loading To Cocolalla Lake

<u>Tributary</u>	<u>Modeled Load (kg/yr)</u>	<u>Measured Load (kg/yr)</u>	<u>% of Load</u>
Fish	334	283	10
Johnson	100	124	3
Westmond	353	273	11
Butler	114	155	4
Cocolalla	883	552	27
Subtotal	<b>1784</b>	1387	<b>55%</b>
Septic Systems	118	54	4
Atmosphere	242	111	7
Internal loading	1100	500	34%
Total	<b>3244</b>	2052	100%

**Table 3.** Load Allocations by Source

<u>Source</u>	<u>Load Reduction (kg/yr)</u>
Fish Ck	269
Johnson	81
Westmond	296
Butler	108
Cocolalla	727
Septic Systems	108
Atmosphere	188
Internal Loading	916
Total Load Reduction	<b>2693</b>

### **5.e. Monitoring Plan**

The Citizen Volunteer Monitoring Program collects dissolved oxygen data on Cocolalla Lake monthly from May to September. The most critical time to measure dissolved oxygen would be in late August and September when oxygen levels would be at their lowest concentration. The DEQ's beneficial use reconnaissance surveys are to be conducted once every five years. Due to the variable nature of nutrient loading to the lake, two concurrent surveys showing full support status should be obtained before de-listing is considered. During those ten years there also should not be a significant algae bloom in the lake.

### **5.f. Margin of Safety**

A 20% margin of error was added to the dissolved oxygen target, reducing it from 10µg/l to 8µg/l (see section 5.a.). An additional margin of safety also exists in the monitoring plan of this TMDL (see section 5.e.).

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